November 15, 1962

Non-Vacuum Window

Roy's report on the flight test program was completed and distributed yesterday.

Vacuum Window

Ultrasonic Welding: We have experienced a number of breakdowns with the welding horn, component failures, broken wires, etc. and these have effected our schedule detrimentally. The problems associated with the variations in ultrasonic welding horn performance have been discussed with W. R. Olha in some detail and he has several suggestions as to techniques which could be used to obtain a quantitative indication of what the actual power being delivered to the horn is.

Hydrogen Brazing: The brazing of 14 x 20 foils is progressing very well. We have made four foils since establishing the correct brazing temperature at Kerns. All four have been tight. Kerns has had some trouble with their furnace in the past week and we were not able to maintain our schedule of one foil per day. However, the furnace has been replaced and we anticipate no difficulty in this area.

Resistance Welding: Barry Robinson arrived at Taylor-Winfield yesterday morning. The purpose of this trip is to attach aluminum faceplates to a leaky 14 x 20 frame of correct surface resistivity, in order to determine whether or not there are any problems which become apparent by this method; which we do not anticipate. If there are no problems evident, he shall attempt to attach aluminum to a tight 14 x 20 frame before he returns tomorrow.

Induction Welding: Bellows were attached to three 7 x 10 frames; two of which were previously tight and one which had had a leak rate of 200 x 10-8 std cc/sec. These frames had previously had reinforcing ribs attached. The resultant leak checks on these frames indicated that they leaked. The leak is most probably from one of two causes; a leak caused during rib attachment, or a leak caused by a poor bellows braze. We believe that it is the latter, and that the reason for this is the slightly different heat sink condition in the actual frame with rib attached from the frames used in practice. We are in the process of checking the location of the leak, and if it is at the bellows, we feel that there is a high probability that we can rebraze to obtain a satisfactory seal.

Miscellaneous: The valve test was completed and the results indicate that the valve works as specified by the manufacturer and is completely satisfactory for our use at elevated temperatures.

The Vac-Ion test program report has been written and final draft is being typed. It shall be distributed tomorrow.

The seal suppled by Parker was attached to the vacuum system by the glassblower last night. Preliminary pump down indicates that there is a leak in the system which Ed feels is most probably at the Parker O-Ring itself. Work on this alternative sealing method shall continue this week.

Previous derivations of equations for the vacuum calculations ("outgassing", "Gettering" and "Leak Rate') are being reviewed and written in a non-classified form for publication, if cleared and approved, as a P-E Technical Report.

Work on the mount is continuing.

A calculation pertinent to the decision whether noncontrolled ground glazings can be converted to control ground glazings with a sufficiently high reliability for use is being performed. Incidentally, a discussion with [redacted] reveals that they feel that it would be possible to regrind and figure to the optical quality required glazings which have already been cut rectangular.

25X1

The consultant from the Dictaphone Corporation declined our offer.

25X1

[redacted]

cm

REPORT OF TEST [redacted] ACTIVITIES - NON-VACUUM WINDOW STAT

22 OCT. 62 - 5 NOV. 62

I OBJECTIVES

The overall objectives of the test [redacted] program as regards the non-vacuum window can be grouped into three broad catagories: STAT

1. Supervision of window installation and coordination with Vehicle People regarding any problems thereof.

2. Familiarization of permanent personnel with the construction of the window as well as proper assembly, disassembly, and handling procedures.

3. Flight test of the window; including mounting within the vehicle of the necessary test instrumentation.

Specific objectives encompassed within the flight test objective include:

1. Visual determination of the overall effects upon the window assembly resulting from exposure to flight environment. Of particular significance are inspection for evidence of structural failures and inspection for evidence of condensation within gap.

2. Determination of heat transfer characteristics of window assembly.

3. Determination of vibration levels to which window assembly is exposed.

II OVERALL PROCEDURES

A. Window Installation & Flight Preparation

Window cutouts were marked, and mounting holes were drilled in the hatch using the drill jig provided by us. It was mutually agreed that the window cutouts would be made 0.05" larger all around for ease in mounting. The windows were then tried for fit, and although it was necessary to do a very slight amount of hand filing on a few of the mounting holes in the lower retainers, the fit of both windows was essentially perfect.

The BK-7 in unit No. 1 was then replaced with the instrumented test glazing and the windows were installed and sealed into the hatch using RTV 60. Unit No. 1 was mounted in the forward recess, and No. 2 in the aft recess.

Both windows were purged prior to each flight to remove moist air within the gap. This was accomplished at first by alternately evacuating the gap and filling with helium. Subsequent to ATF 1 it was felt that better results would be obtained by inserting a small plastic tube into the gap, through the window vent tube, and flushing with helium for 15 minutes. New desiccators were used for each flight.

B. Instrumentation

Unit No. 1 was instrumented as shown in Figure 1. In addition to the

thermocouples shown, additional thermocouples were placed:

1. Between skin and mount in right forward corner of unit #1
2. On inner surface of skin at center of hatch
3. In center of bay approximately 6" above skin

An accelerometer for measuring vibrational levels perpendicular to the plane of the window was mounted at the center of the test glazing; and a clock-type temperature recorder was mounted on the hatch approximately 6" above the skin to record bay temperature as a function of time. Thermocouples were copper-constantan. Reference junction was constant power oven at 75°C.

Thermal and vibrational data were recorded by means of two 12 channel century recorders mounted on the hatch. Accuracy of temperature measurement is estimated as ±5°F. Running time of the recorders is approximately nine minutes at two inches/sec chart speed. Vehicle operator was instructed to actuate the recording equipment as follows:

1. Two minutes at takeoff.
2. Thirty seconds every ten minutes during flight, with a maximum of eight cycles.
3. Three minutes at landing

III DISCUSSION OF RESULTS

The window was flown a total of three times in Veh. #3. Flight parameters as well as measured thermal data are summarized in Figures 2 through 4. For purposes of discussion the test results will be broken down into three broad catagories.

A. Visual Post-Flight Inspection

Post flight inspection showed the windows to be in excellent condition. No evidence of structural failure could be found. Check of all accessible fasteners with a torque wrench showed that no loosening had occurred. No evidence of gap condensation could be found. The latter is particularly encouraging as the makeup for these flights was air rather than helium.

B. Thermal Characteristics of Window Assembly

Measured temperature for the three test flights are summarized in Figures 2 through 4. For the mount and glass temperatures, the plotted points represent the average, as well as the high and low readings for eight mount thermocouples and seven glass thermocouples. Skin temperatures represent the reading of the thermocouple situated between the skin and the mount. Bay temperature represents the readings of the clock-type recorder located on the hatch.

One important item must be realized before an attempt is made to extract quantitative information from the plotted data. This is the fact that flight parameters (speed, altitude, and duration) were vastly different

from the design conditions of the window. This has the effect of lowering the temperature differential between inner and outer window surfaces to the point where:

1. The validity of thermal calculations becomes extremely questionable.
2. The effect of changing mount spacers becomes almost negligible. (changing spacers, therefore, was not considered for this test series).

As an example, consider the data of ATF 2 (Figure 3). At approximately 1110 hrs., mount and glass temperatures were 73°F and bay temperature was 78°F. Calculation of expected skin temperature yields a value of 68°F which is almost identical to the measured skin temperature of 65°F. However, the total differential being but 8°F, an error of only 2°F would result in a 25% error in calculation. Moreover, the calculated effect of the total possible change in mount temperature which could result from our changing mount spacers is but 6°F as opposed to an expected 60°F for design conditions.

As regards the test data itself, one recorder did not function for ATF 1 due to the accidental breakage of a wire during hatch installation. Therefore, glass temperatures and vibration data were not obtained for this test. For ATF 3, the vehicle operator failed to report the times at which he actuated the recording equipment and although the data is presented in Figure 4, the times at which these data were obtained is unknown.

For ATF2(Figure 3) all equipment functioned properly; and flight parameters (constant altitude and speed, 2 hour duration) were the best of the three flights for approaching steady state conditions. It is felt, therefore, that the data of this test is the most useful as regards thermal characteristics. Figure 3 shows that measured mount and glass average temperatures are within 2°F of each other, and that the maximum spread is ± 3°F which is well within estimated accuracy limits of ± 5°F. Calculated overall heat transfer is of the order of 5 BTU/ft^2-HR and calculated inner skin temperature is 68°F versus measured values of 62°F-65°F during the latter portion of the mission. At a mach no. of 0.85 the temperature ratio of total temperature to ambient temperature is 1.142. Assuming outer skin (and glass) temperature of 60°F, the calculated ram rise recovery is 95% which seems rather high. Vehicle People estimate ram rise recovery at approximately 80% based on skin temperature measurements at the upper hatch. This would yield an outer skin temperature for ATF 2 of 50°F.

C. Vibration Levels

Vibration measurements were made in a direction perpendicular to the plane of the window by means of an Endevco 2219 accelerometer mounted at the center of the test glazing. Response of the accelerometer plus galvonometer is flat from approximately 7 cps to 90 cps with about a 6 db/octave roll-off above and below these frequencies. Maximum vibrational loadings occurred at the lowest noticeable frequencies and were 1.3G at 1.5 cps for ATF 2, and 1.4G at 1 cps for ATF 3. At the highest frequencies noted,

vibration levels were 0.5g at 70 cps for ATF 2, and 0.1g at 70 cps for ATF 3.

Calculated resonant frequency of the glazings is approximately 480 cps which is fairly close to the upper end of the presently expected input vibrational spectrum. It is therefore felt that there is no cause for concern as regards window resonance.

IV CONCLUSIONS AND RECOMMENDATIONS

The work performed and the conclusions reached may be summarized as follows:

1. Windows satisfactorily installed in hatch.

2. Windows were flown under a variety of flight parameters and survived in excellent condition.

3. Desiccating system proved satisfactory.

4. Thermal calculations based on test data, although subject to the limitations discussed in this report, are nevertheless consistent with analytically predicted results.

5. Vibration levels are fairly low and appear to be within safe limits as regards the windows.

6. Instrumentation for future flight testing of windows has been installed, and most problem areas pertaining thereto have been ironed out.

7. Permanent party personnel have been briefed regarding window handling, assembly, etc., and it is felt that the need for window group supervision should therefore be considerably lessened.

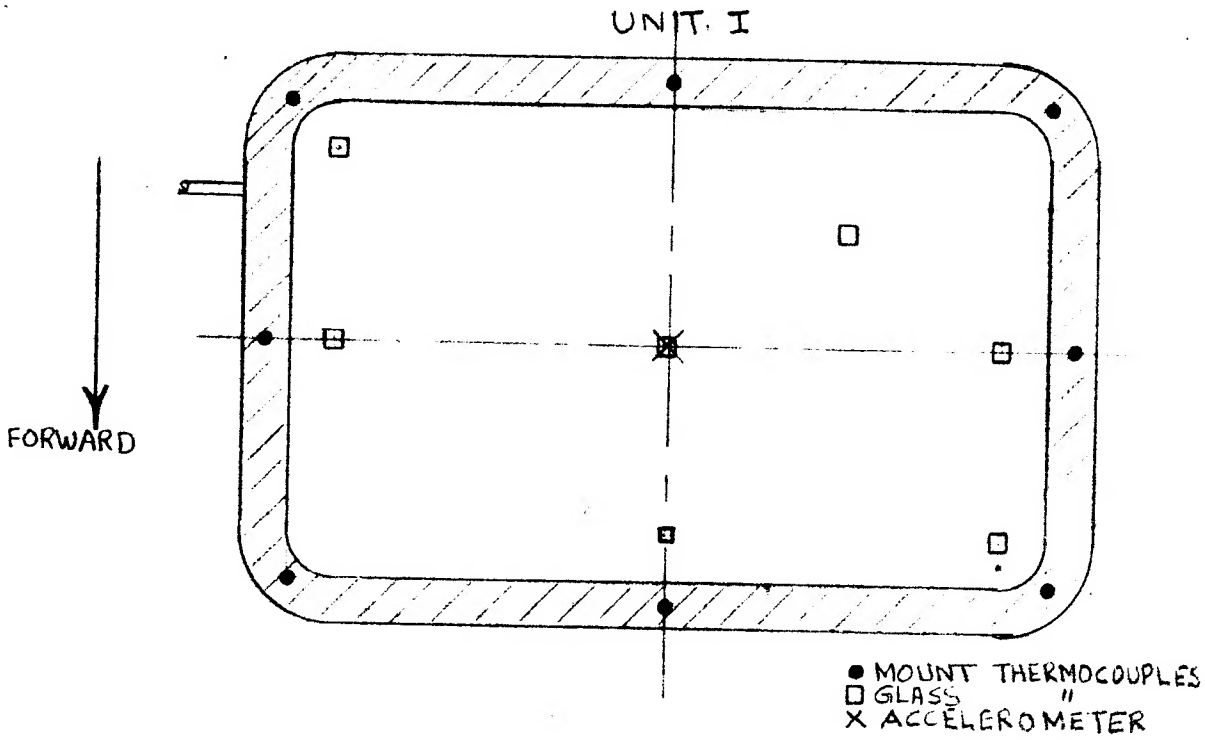
The following recommendations are suggested for future window flight testing:

1. Flights should be of minimum two hour duration at constant speed and altitude to allow steady state conditions to be reached.

2. Provision should be made to insure that vehicle operator actuates recording equipment as called for in the flight plan and reports time, speed and altitude when doing so. It is suggested that a clock type mechanism be installed in the bay which would record the times at which the equipment is actuated. It is further suggested that, if possible, one of our people be present in the control tower during flight, so that if any deviation from flight plan occurs, corrections can be made during flight.

STAT

THERMOCOUPLE LOCATION



NOTE: ALL COUPLES ON INNER (BAY SIDE) SURFACE OF GLASS & MOUNT

HATCH INSTALLATION

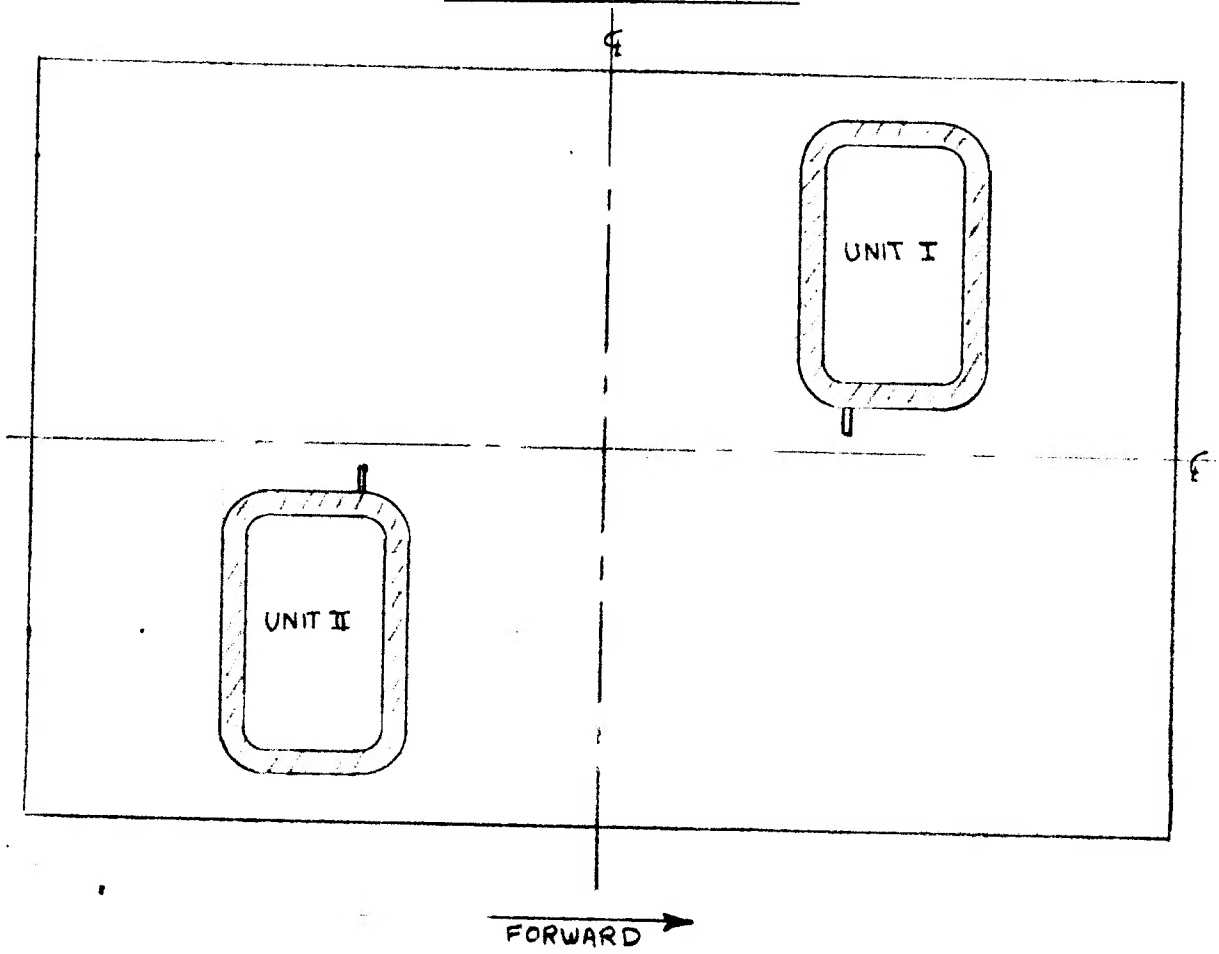


FIG 2.

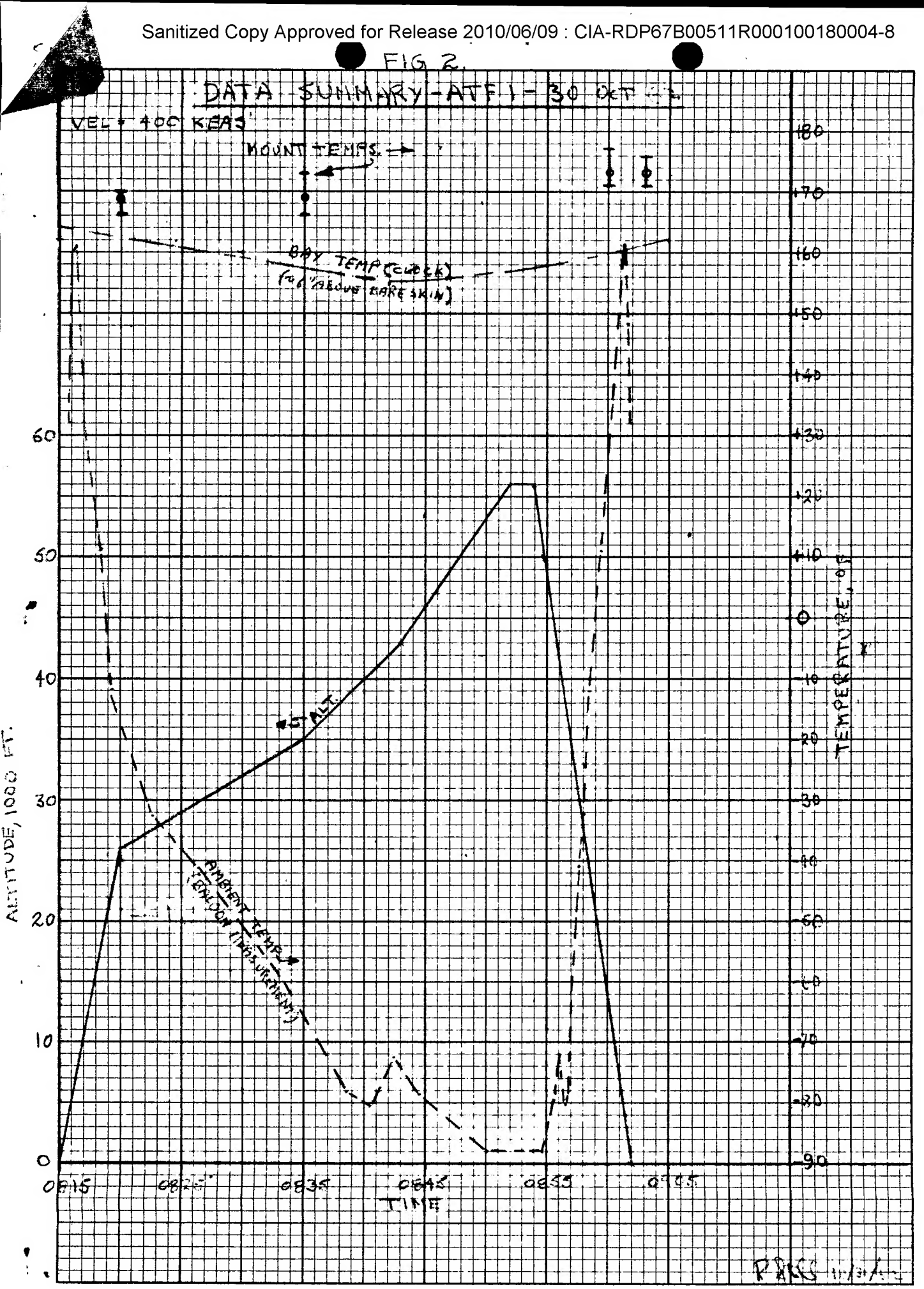


FIG 3

DATA SUMMARY - ATF 2-3 NOV 62

VELOCITY = 0.85 MACH
BAY TEMP ≅ 78 °F

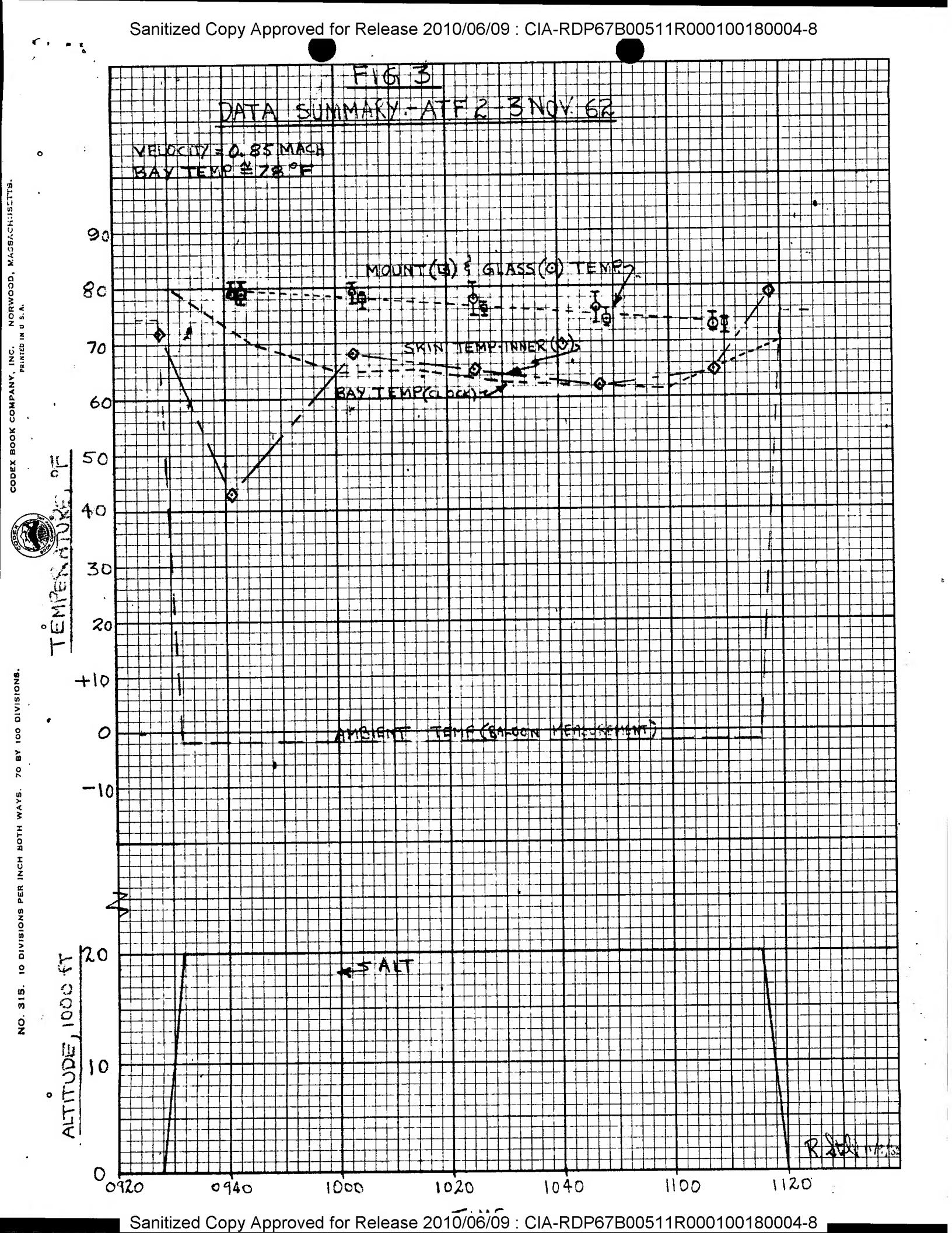


FIG. 4
DATA SUMMARY - AT F-3 - 3 NOV. 62